U.S. DOE-RMI Annual Meeting

Science Program Briefing

"CONDITIONS ARE IMPROVING"

Terry Hamilton
Scientific Director, Marshall Islands Dose Assessment and Radioecology Program
Center of Accelerator Mass Spectrometry
Lawrence Livermore National Laboratory
Livermore, CA 94550
USA

LLNL-PRES-774030
This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract DE-AC52-07NA27344, Lawrence Livermore National Security, LLC

Lawrence Livermore National Laboratory

LLNL Marshall Islands Program

SCIENCE PROGRAM BRIEFING:

Public Law 112-149 Continued Monitoring of Runit Island

Terry Hamilton, Scientific Director
Marshall Islands Dose Assessment and Radioecology Program

U.S. DOE-GRMI Annual Meeting
Majuro
Republic of the Marshall Islands
May 15-16, 2019

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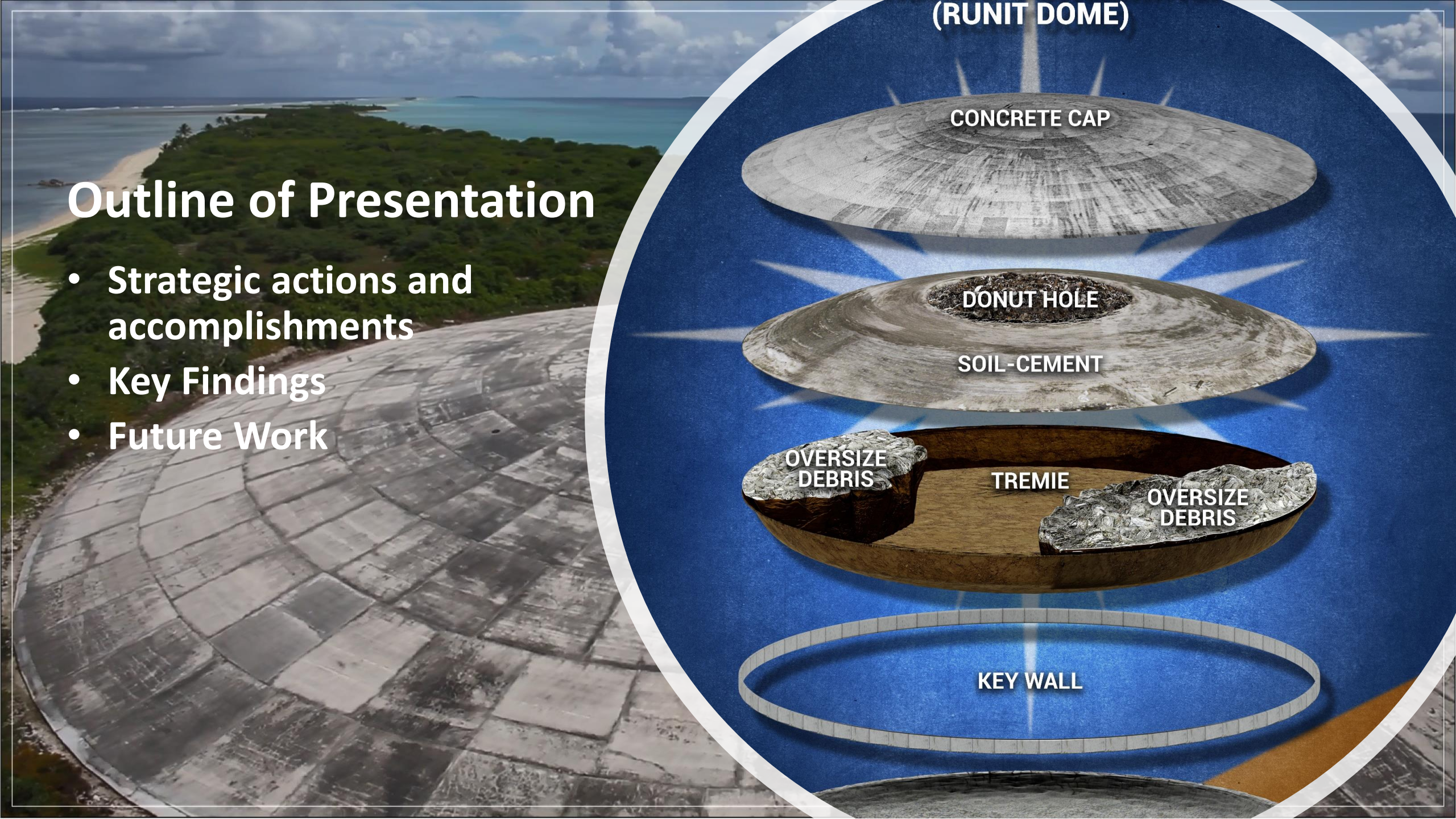
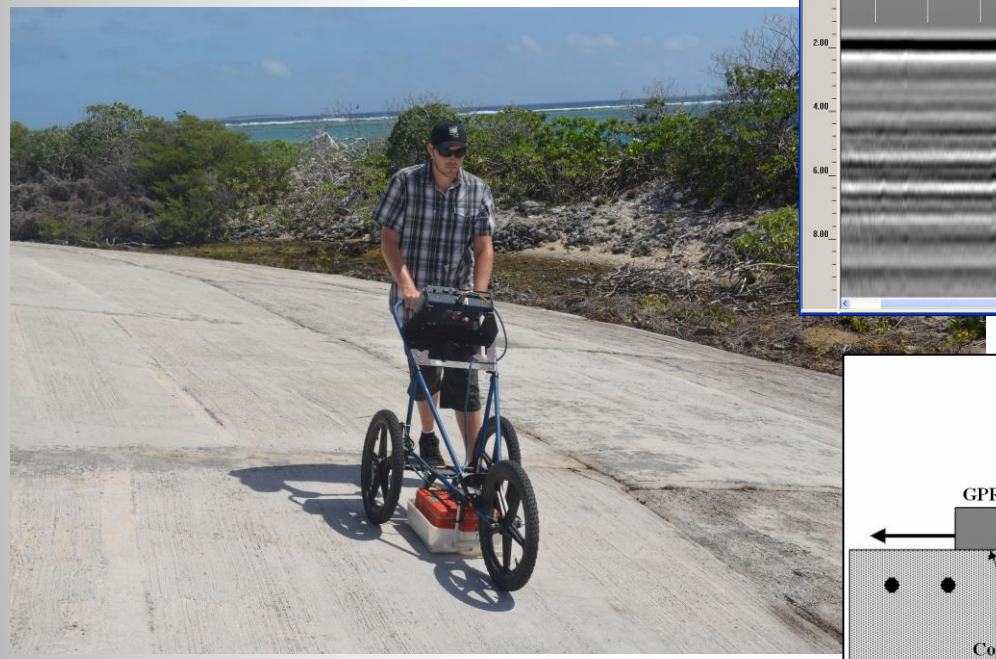
Outline of Presentation

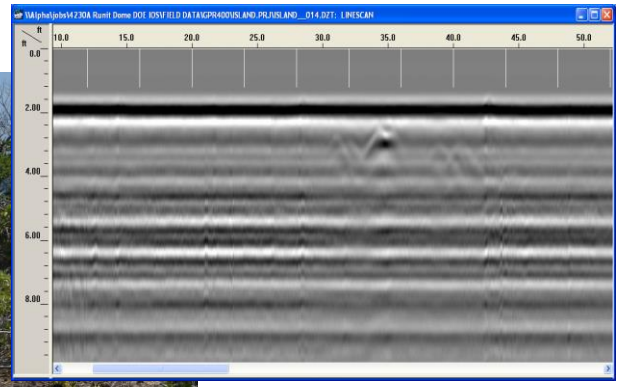
- Strategic actions and accomplishments
- Key Findings
- Future Work

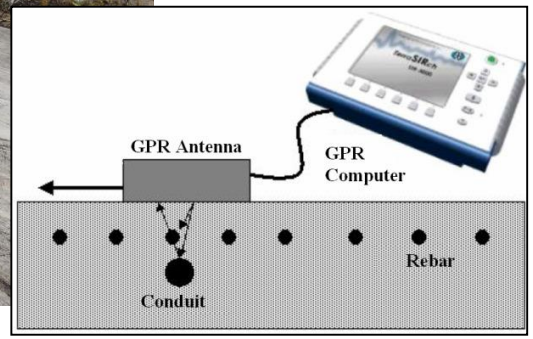


Strategic Actions and Accomplishments (2013-present)

- **2013, Together with external consulting experts, successfully completed and published an initial engineering and visual survey of the concrete cap covering the waste containment structure**

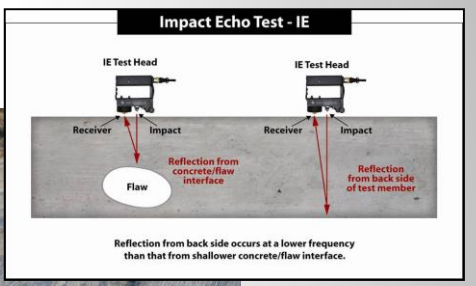






Ground Penetrating R

[Nondestructive testing of the integrity of the concrete to identify voids (air pockets) and other reflective anomalies down through the waste pile]



nents based on
no

[Provided a measure of the thickness of the concrete cap]

Hamilton 2013, A Visual Description of the Concrete Exterior of the Cactus Crater Containment Structure, LLNL-TR-648143)

LAWRENCE LIVERMORE NATIONAL LABORATORY

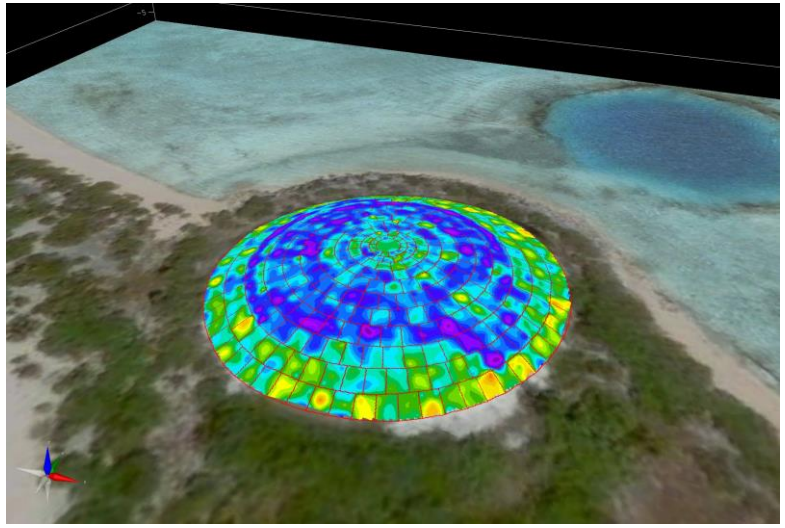
LLNL-TR-648143

Report

A Visual Description of the Concrete Exterior of the Cactus Crater Containment Structure

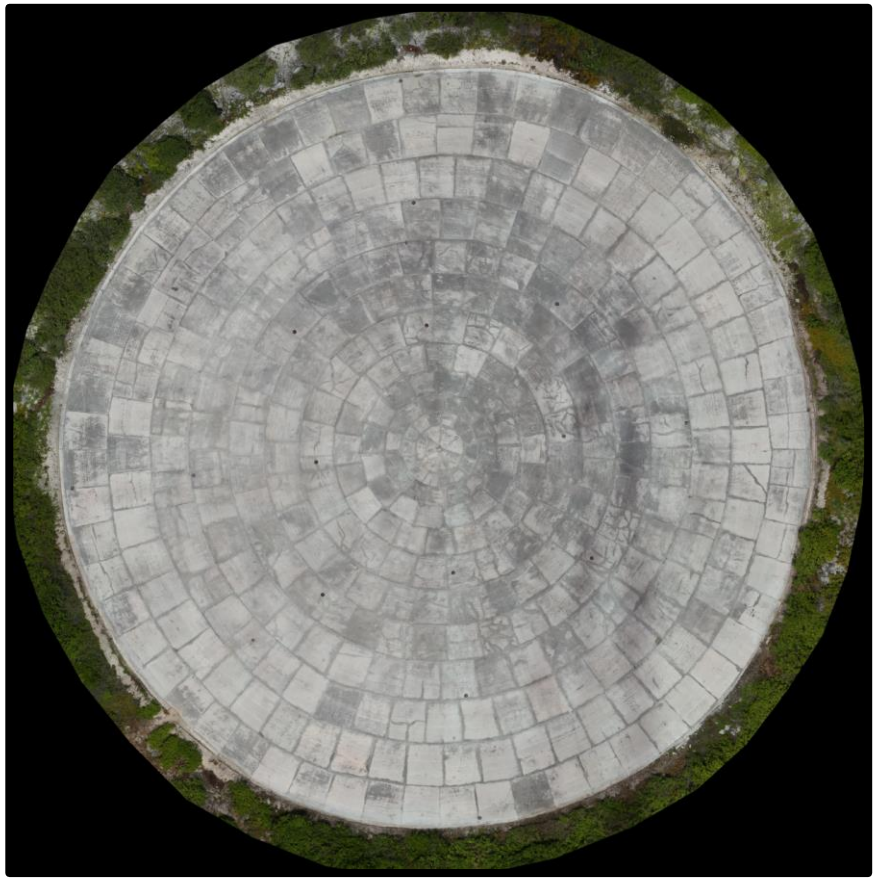
Terry Hamilton

October 2013

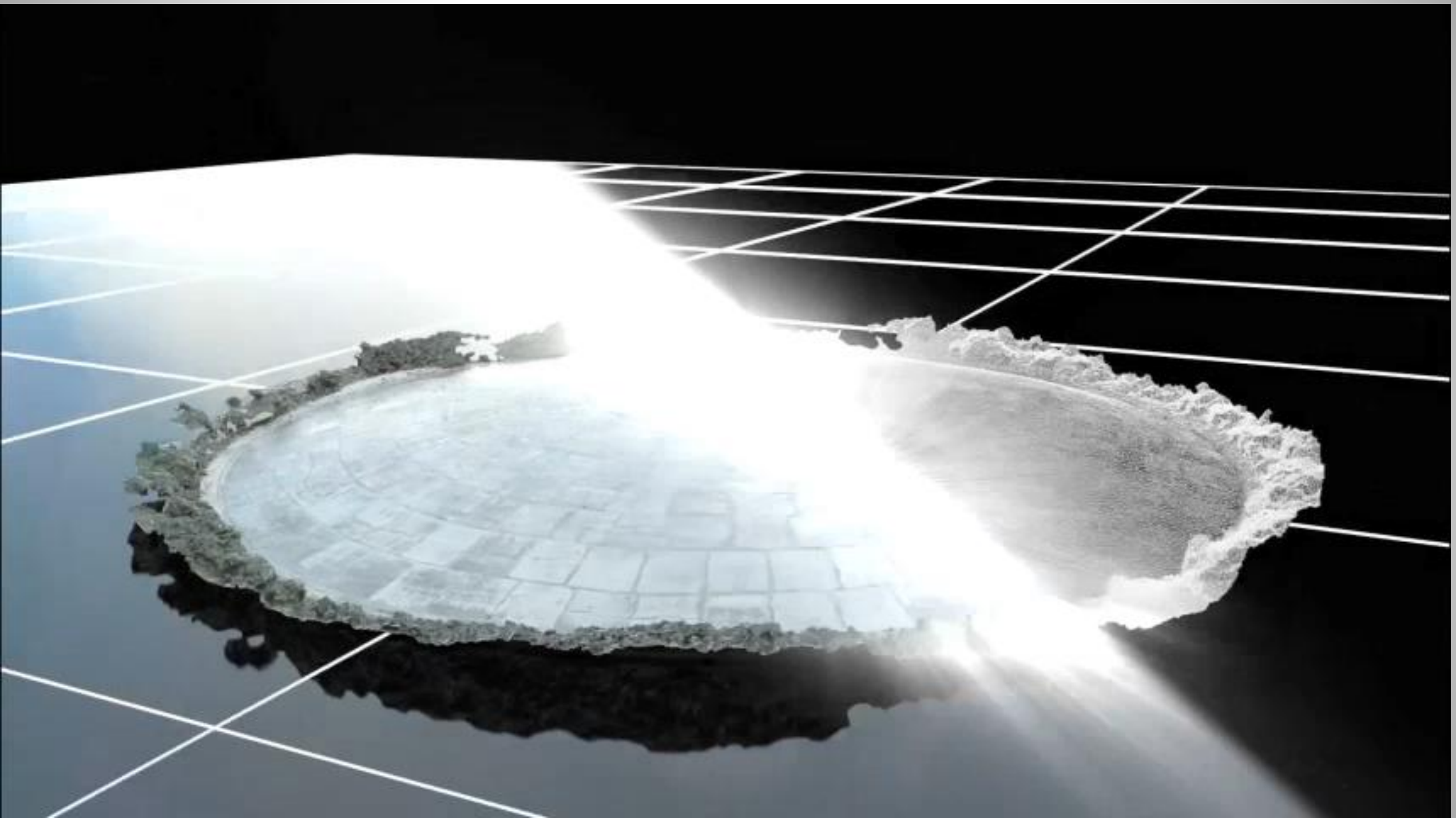


Strategic Actions and Accomplishments (2013-present)

> 2018, Conducted a visual survey of the waste containment structure

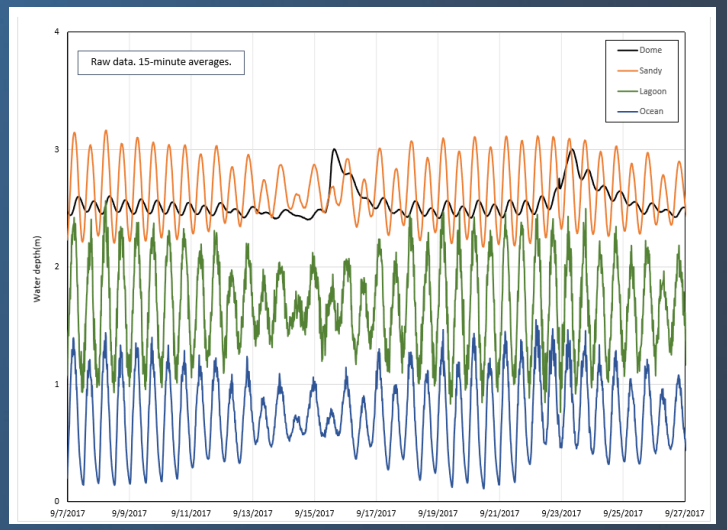


3-D Mosaic Model



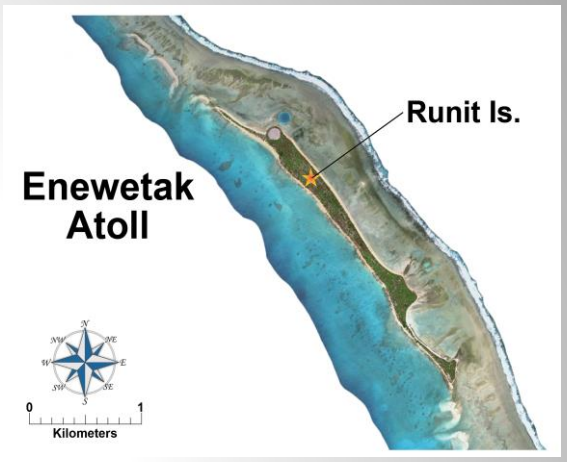
Strategic Actions and Accomplishments (2013-present)

- 2013, Re-established and conducted initial pump tests on National Academy of Sciences (NAS) boreholes positioned on and around the containment structure
- 2013-2018, Collected initial sets of groundwater samples from on and off the containment structure for measurement of radionuclides and other water quality parameters



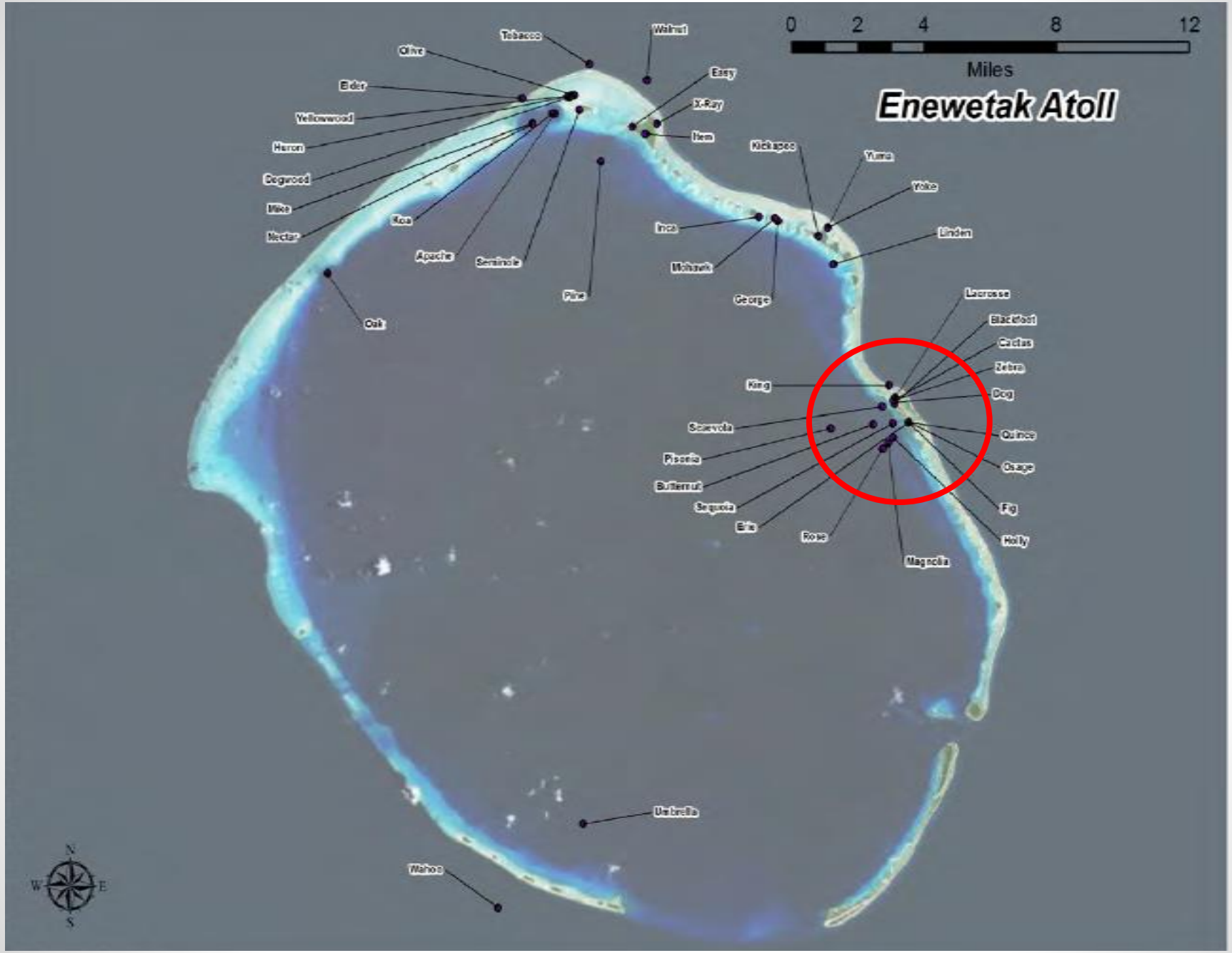
(salinity 2-4 ppt, pH ~ 12.4)

Initial Measurement of Fallout Radioactivity in the *Runit Dome Borehole*

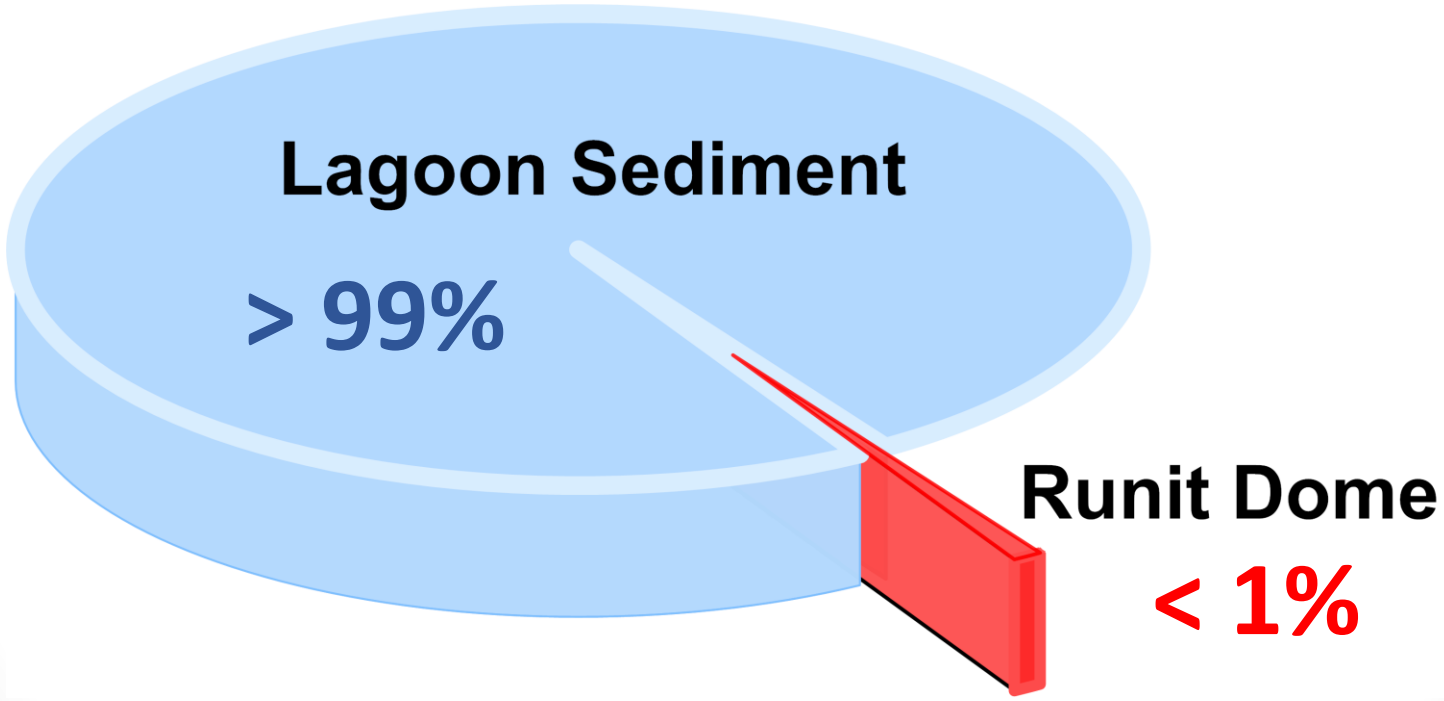


Radionuclide	Units	Concentration	Groundwater	Lagoon Water
			Surface Ocean	Surface Ocean
^{90}Sr	Bq L^{-1}	6.30±0.08	6000-9000	~1-3
^{137}Cs	Bq L^{-1}	2.15±0.04	1000-2000	~1-3
^{129}I	μBq L^{-1}	63±3	3000-4000	~1-2
$^{239+240}Pu$	mBq L^{-1}	0.73±0.02	200	~100

Where is this excess plutonium coming from?

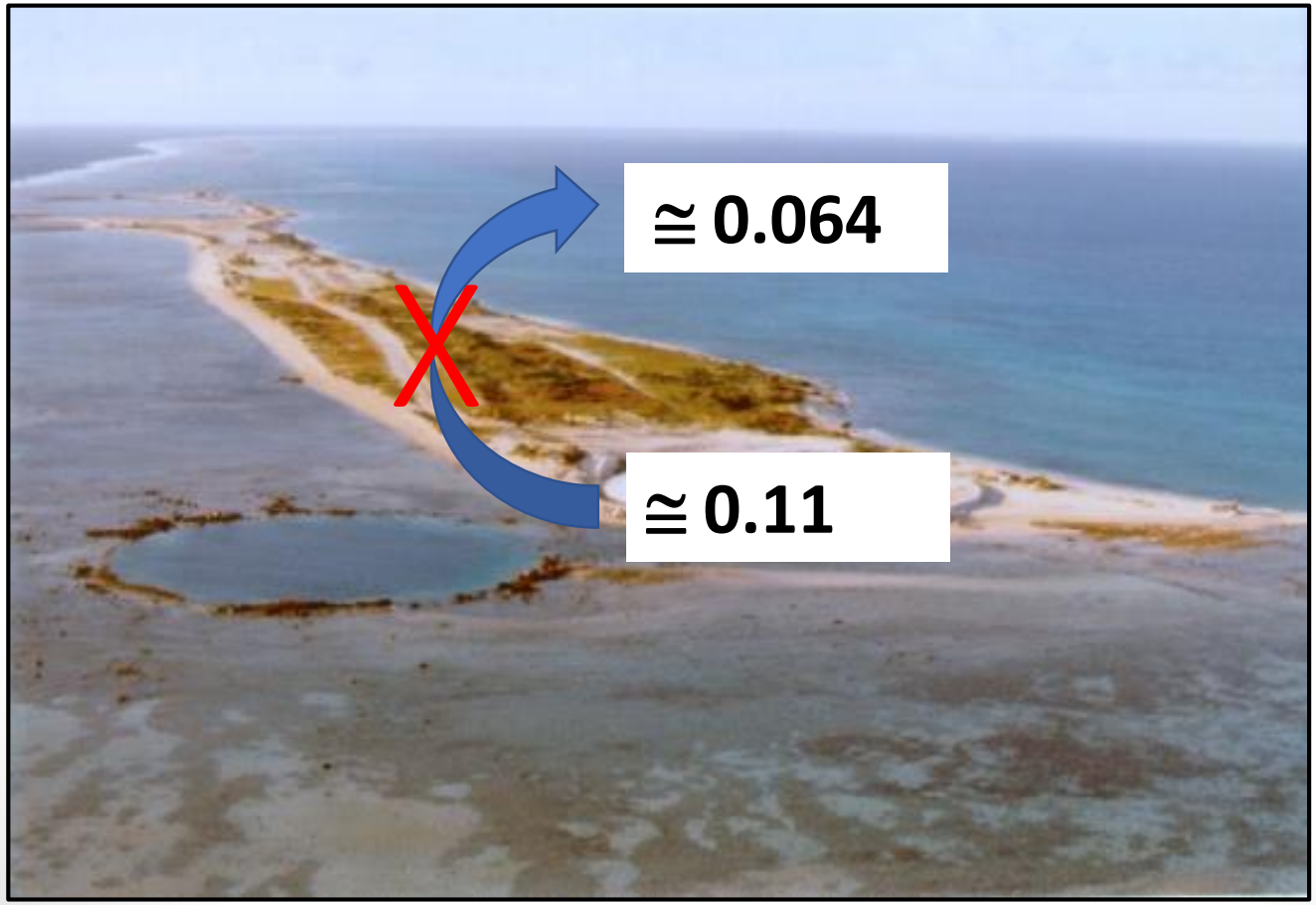

Enewetak Atoll
0 2 4 8 12
Miles
Tobacco
Walnut
Olive
Easy
Elder
X-Ray
Yellowwood
Item
Kickapoo
Yuma
Heron
Yoke
Dogwood
Inca
Linden
Mike
Koa
Nectar
Apache
Seminole
Mohawk
Pine
George
Oak
Lacrosse
Blackfoot
Cactus
Zebra
King
Dog
Scaevola
Quince
Pisonia
Orange
Butternut
Sequoia
Fig
Ellis
Rose
Holly
Magnolia
Umbrella
Wahoo
N
W
E
S

- **Much more plutonium in the lagoon sediment compared with what was placed inside the waste contaminant structure**



- **Plutonium carries with it a characteristic fingerprint based on make up of the element**

e.g., the $^{240}Pu/^{239}Pu$ atom ratio



General Conclusions

- The containment structure remains vulnerable to leakage and the sustained impacts of storm surge and sea level rise
- Surface groundwater samples collected from inside the containment structure contain relatively high concentrations of fallout radionuclides (1000 to 6000 times higher) compared with that observed in the open ocean
- There is clear evidence of direct communication of the groundwater inside the containment structure with the surrounding ocean and lagoon
- Based on isotopic analyses, the local marine radiation environment adjacent to Runit Island is dominated by plutonium mobilization from sedimentary sources to solution, … not from leakage of radioactive from the concrete containment structure
- The groundwater hydrology beneath the containment structure is very complex showing strong salinity, pH and contaminate gradients. This is further exasperated by the heterogeneous nature of the physical placement of waste inside the containment structure

Continuation Studies

- **Chemical and Compression Strength Testing of Concrete Cores**

General Findings

- Aggregate materials were well graded, properly shaped, uniformly distributed, and hard to fairly hard
- No excessive fines or ‘dirty’ aggregate were found
- Concrete was not air-entrained
- Longitudinal and transverse small macro-cracks were generally limited to the exterior surfaces of the concrete
- Thin sections revealed a wide range of micro-cracking between the cores
- Compressive strength of concrete 4500-10,000 psi
- Load capacity = 49,000-111,000 lbs

Conclude that micro-cracking and small macro-cracks along the exterior portion of the concrete do not appear to be adversely affecting the strength properties or integrity of the concrete

FUTURE WORK

- As funding becomes available from the DOI, develop a network of groundwater sampling wells located on and off the containment structure[#]

  These sampling wells will be located in different geologic media and at different depths
- Conduct an extensive period of sampling and analysis of groundwater and lagoon/ocean water over a period of 18 months covering several seasonal cycles to support ability to model the potential impacts of contaminated water flows reaching outfall points in the lagoon
- Provide a scientifically defensible and credible basis for determining the frequency of sampling under a long-term groundwater monitoring program, and ensuring the health and safety of the people of Enewetak
- Continue to provide maintenance activities of the concrete façade covering the containment structure to include removal of rooting vines, and repair of concrete spalls and cracks

[#]T.F. Hamilton (2017). Drilling, sampling and installation of groundwater monitoring wells on Runit Island, Enewetak Atoll, Republic of the Marshall Islands, Request for Proposal (RFP) Background Documentation, LLNL-MI-733219.

Session End

QUESTIONS